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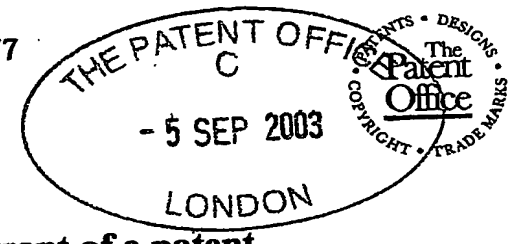

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1. Your reference — SPC/JB/P11457GB

2. Patent application number *(The Patent Office will fill in this part)* — 0320858.4 — 5 SEP 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)* — Applied Design and Engineering Limited
5 Tower Road
Lowestoft
Suffolk NR33 7NG
United Kingdom

   Patents ADP number *(if you know it)* — 8155376001

   If the applicant is a corporate body, give the country/state of its incorporation — England and Wales

4. Title of the invention — Improvements in or relating to Seals

5. Name of your agent *(if you have one)* — David Keltie Associates

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)* — Fleet Place House
2 Fleet Place
London EC4M 7ET
United Kingdom

   Patents ADP number *(if you know it)* — 040145020006

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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11. I/We request the grant of a patent on the basis of this application.

Signature: David Keltie Associates

Date: 5 September 2003

David Keltie Associates

12. Name and daytime telephone number of person to contact in the United Kingdom

Jakob Bumke
020 7329 8888

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IMPROVEMENTS IN OR RELATING TO SEALS

This invention relates to storage and in preferred embodiments relates to the art of cold storage, including appliances such as refrigerators and freezers for storing foodstuffs and other perishables. Other applications of the invention include storage of chemicals and medical or biological specimens. The invention also finds use in mobile applications, for example in the transport and storage of perishable goods. More generally, the invention finds use in any form of storage involving the use of drawers, but particularly where the drawers need to be sealed when closed.

The invention finds particular benefit in the context of the Applicant's multi-compartment cold storage appliances of the general type disclosed in its co-pending patent applications WO 01/020237, WO 02/073104, WO 02/073105 and WO 02/073107, the contents of which are incorporated herein by reference, and develops and adds to certain features of those specifications while omitting or varying other features. As in those specifications, the invention can be applied to storing any items whether within a cooled environment or otherwise. The term 'appliance' is therefore to be construed broadly, extending beyond fixed domestic devices into industrial, scientific and mobile applications. However, this specification will particularly describe domestic or commercial cold-storage appliances for storing foodstuffs.

The compartments of the appliances disclosed in WO 01/020237, WO 02/073104, WO 02/073105 and WO 02/073107 are drawers sealed from one another to minimise cross-contamination, waste of energy and icing. Optionally, there is provision to select different temperatures in different compartments to suit different foodstuffs or other contents, and to suit different cold-storage regimes such as refrigeration marginally above zero Celsius and freezing significantly below zero Celsius. Indeed, it is possible for a given compartment to be converted readily from refrigerator to freezer and back again, thereby to vary the proportion of refrigerator space to freezer space in the appliance as a whole. In this way, the appliance can respond to changing cold-storage needs.

Briefly to recap the introduction of WO 01/020237, the advantages of storing foodstuffs and other perishable items in refrigerated and segregated conditions have long been known: refrigeration retards the degradation of such items and segregation helps to prevent their

cross-contamination. Accordingly, modern cold-storage appliances such as refrigerators and freezers are usually compartmentalised, albeit not often effectively, so that a user can store different types of food in different compartments. All such appliances have the additional aim of maximising their energy efficiency.

The invention herein and the inventions in the Applicant's earlier patent applications WO 01/020237, WO 02/073104, WO 02/073105 and WO 02/073107 mentioned above were devised against a background of typical cold-storage appliances, most of which comprise one or more upright cabinets each with a vertically-sealed hinged door on its front. Substantially all of the interior of the cabinet defines a storage volume, most commonly partitioned by shelves or drawers for supporting stored foodstuffs. Access to all of the shelves or drawers in the cabinet is gained by opening the door.

A cooler unit generates a convection loop within the cabinet, in which air cooled by the cooler unit sinks toward the bottom of the cabinet and as that air absorbs heat during its downward journey, it warms and rises back up to the cooler unit where it is cooled again. It is also possible to have forced-air circulation by means of a fan within or communicating with the cabinet. The shelves or drawers are typically made of wire so that they offer little resistance to this circulation of air.

WO 01/020237, WO 02/073104, WO 02/073105 and WO 02/073107 address a major problem with upright refrigerators and freezers, namely the upright door which, when opened, allows cold air to flow freely out of the cabinet to be replaced by warm ambient air flowing in at the top. That rush of ambient air into the cabinet causes its internal temperature to rise, hence consuming more energy in redressing that rise by running the cooler unit. The incoming ambient air introduces the possibility of airborne contamination, and moisture in that air also gives rise to condensation and ice within the cabinet. The more often and frequently the cabinet is opened, as may happen especially in commercial cold storage appliances, the worse these problems get.

In upright-door arrangements, the limitations of the vertical seal mean that loss of cold air and induction of warm air can even occur when the door is closed. Being denser than warmer air, the coldest air collects at the bottom of the cabinet and applies pressure to the sealing interface

so that unless the seal forms a perfect seal between the door and the cabinet, that air will escape.

The appliances disclosed in WO 01/020237, WO 02/073104, WO 02/073105 and WO 02/073107 also address the problems inherent in the well-known chest freezer, whose open-topped cabinet is typically closed by a horizontally-hinged upwardly-opening lid. Such a chest freezer is inconvenient and wasteful of space because it precludes use of the space immediately above the freezer, which space must be preserved to allow its lid to be opened. Even if a sliding lid is used instead of an upwardly-opening lid, items cannot be left conveniently on top of the lid. It is also well known that large chest freezers can make access to their contents extremely difficult, it being necessary to stoop down and shift numerous heavy and painfully cold items to get to items at the bottom of the freezer compartment.

Finally, the appliances disclosed in WO 01/020237, WO 02/073104, WO 02/073105 and WO 02/073107 address the problem of segregating different types of foodstuff or other perishable items to avoid cross-contamination. In typical cold-storage appliances, segregation of food is compromised by the convection and/or forced-air principles on which those appliances rely. The substantially open baskets or shelves designed to promote convective circulation of air between the compartments also promote the circulation of moisture, enzymes and harmful bacteria. In addition, any liquid that may spill or leak, such as juices running from uncooked meats, will not be contained by the open baskets or shelves.

Conventional cold-storage appliances exemplified by upright refrigerators and chest freezers are not the only prior art disclosures of interest. For example, it has been known for many years to divide a refrigerator into compartments, each with its own dedicated closure such as a door or lid. Examples of this idea are disclosed in UK Patent Nos. GB 602,590, GB 581,121 and GB 579,071, all to Earle, that describe cabinet-like refrigerators.

In those Earle documents, the front of the cabinet is provided with a plurality of rectangular openings for receiving drawers. Each drawer has a front panel larger than its respective opening so that a vertical seal is formed around the overlap when the drawer is in a closed position. The drawers and their contents are cooled by a cooler unit that circulates cooled air by convection within the cabinet, in common with the types of refrigerator already described. To promote circulation of this air amongst all of the drawers, the drawers are open-topped and

have apertures in their bottoms. Also, the drawers are disposed in a stepped arrangement, those at the top of the refrigerator extending back less far into the cabinet than the lower drawers so that the rear of each drawer is exposed to the downward flow of cooled air from the cooler unit.

Although only one drawer need be opened at a time, the apertures in the bottom allow cold air to flow freely from the open drawer, which is replaced by warm moist ambient air to the detriment of energy efficiency and with the increased possibility of cross-contamination. Indeed, when a drawer is opened, cold air within the cabinet above the level of that drawer will flood out, drawing ambient air into the cabinet. Furthermore, the drawers encourage ambient air to flow into the interior of the refrigerator because, upon opening, they act as pistons drawing the ambient air into the interior of the refrigerator cabinet. Once in the cabinet, the warm air can circulate as freely as the cold air that is supposed to be there.

Even when closed, the accumulation of cold air towards the bottom of the cabinet will exert increased pressure on the vertical seals of the lowest drawers, increasing the likelihood of leakage if the seal is faulty.

A further example of the above type of refrigerator is disclosed in UK Patent No. GB 602,329, also to Earle. The refrigerator disclosed therein suffers many of the above problems but is of greater interest in that a single drawer consisting of insulated sides and base is provided within the cooled interior of the cabinet. In contrast to the variants outlined above, the sides and base are solid and not perforated so that air cannot flow through them. When the drawer is closed, a horizontal member within the cabinet combines with the drawer to define a compartment, the horizontal member thus being a closure in the form of a lid for the drawer. This compartment is provided with its own cooling coils situated just below the horizontal member.

Very little detail is given about the seal that is formed between the drawer and the horizontal member, other than that the horizontal member has a downwardly projecting rear end with a biased edge that makes a close fit with the rear wall of the drawer. Nothing else is said about the junction between the drawer and the horizontal member, apart from the general statement that the drawer is adapted when in its closed position to fit 'fairly snugly' against the horizontal member. It can only be inferred that the drawer and the horizontal member merely

abut against each other. Whilst this will impede the passage of air into and out of the drawer, it will not form an impervious seal. As this is not a vapour seal, icing and cross-contamination is likely to occur even when the drawer is closed.

The drawer arrangement described creates a compartment in which a different temperature can be set when compared to the essentially common temperature of the rest of the refrigerator. It is particularly envisaged that the drawer can act as a freezer compartment. The Applicant has appreciated a disadvantage in this arrangement, namely that as the freezer drawer resides within the cooled interior when closed, the outer surfaces of the drawer within the cabinet will be cooled to the temperature of the refrigerator. Accordingly, when the drawer is opened, those cooled outer surfaces will be exposed to ambient air containing moisture that will condense on the cooled surfaces leading to an undesirable accumulation of moisture. Condensation involves transfer of latent heat from water vapour to the drawer, thus increasing the burden of cooling the drawer again when the drawer is returned to the closed position within the cabinet.

Additionally, condensed moisture will be transferred to the interior of the refrigerator when the drawer is closed. As discussed above, the presence of water promotes microbial activity. A further disadvantage of introducing water into the interior of the refrigerator is that it may freeze: this can be a particular problem where the drawer of the enclosed compartment meets the insulated top, as any ice formation will form a seal that locks the drawer in a permanently closed position. This disadvantage was appreciated by Earle, as a cam mechanism is mentioned in GB 602,329 to break any ice formed at the seals or on the runners or other support surfaces of the drawers. It is also possible for a build-up of ice to affect the sealing ability of the seal, by preventing mating sealing surfaces from mating correctly. Of course, the accumulation of ice on moving parts of the drawer mechanism is also undesirable as it will impede movement of the drawer.

A further interesting prior art document, cited as technological background against WO 01/020237, is US Patent No. 1,337,696 to Ewen. Ewen speaks of segregation between refrigerated drawers contained in a surrounding cabinet and employs refrigerating units placed 'immediately and closely above each drawer... so that said drawer may in effect be said to be closed against said refrigerating unit'. However, there has to be a gap left between the drawer and the refrigerating unit if the drawer is going to open. As in Earle, that gap will

promote icing as moist air within the cabinet migrates into the drawer and the water vapour condenses and freezes. The smaller the gap, the sooner the accumulating ice will prevent drawer movement. If a larger gap is tried instead, there will be a greater spillage of air and hence the refrigerator will be less energy-efficient and more susceptible to cross-contamination.

That aside, the spillage of cold air in Ewen lowers the temperature within the cabinet around the drawers, and so increases the likelihood of condensation on the drawers when opened. It will be noted that cold air spilled in this way can fall freely behind the drawers within the cabinet and so expose the exterior of the drawers to air substantially below ambient temperature. Certain design details of Ewen worsen this effect. For example, the bottom wall of the Ewen unit is an efficient insulator which will significantly reduce the surface temperature of the drawers. Also, the internal divisions between the drawers do not allow for ambient heat transfer to the drawers but only for heat transfer between the drawers, thus promoting drawer-to-drawer temperature equalisation over time. Left for long periods, or even overnight, large parts of the external surface of each drawer will fall to temperatures significantly below ambient dew point. Condensation or ice will therefore form on those surfaces as soon as the drawers are opened; similarly, if the drawers are removed and left outside the appliance, they will start to 'sweat' with condensation.

Like Earle, opening and closing a drawer within a sealed cabinet in Ewen acts like a piston, alternately applying both negative and positive pressures to adjacent areas. This promotes air transfer through the drawer opening at the front of the cabinet, which can displace cold treated air in a drawer, and within the cabinet itself. An over-sized cabinet would reduce the piston effect but would also be wasteful of space. Conversely, a more space-efficient close-fitting cabinet may decrease the displacement of cold treated air, and so reduce the burden of cooling the warmer air that takes its place, but it will increase resistance to opening and closing the drawer.

Cold air spillage aside, the gap inevitably left between a drawer and its associated lid in prior art arrangements is large enough to allow the passage of enzymes, spores and other airborne contaminants. Also, Ewen discloses a common interconnecting drain and this too would allow free transfer of contaminants between each drawer, particularly under the aforementioned piston action.

Whilst Ewen speaks of different temperatures in different drawers, the plurality of cooling lids are connected in series and have no means for individual temperature control in each drawer. The different temperatures are designed-in by providing some drawers with more cooling elements than others, but there is no measurement or control of those temperatures in use. Also, like the compartments of more conventional prior art, each drawer in Ewen has a fixed function, namely freezer or refrigerator.

It will be apparent from the foregoing that effective sealing is a prerequisite of efficient cold storage whether in appliances having a vertical seal, exemplified by upright-door refrigerators or freezers, or in appliances having a horizontal seal, exemplified by refrigerators or freezers such as a chest freezer.

Traditionally in the refrigeration art, sealing has been achieved by magnetic seals in which, typically, magnetic strips associated with seals around the periphery of an access aperture attract resilient seal parts into mutual sealing contact when the door, lid or other closure of the cold-storage compartment is closed. The seals can be thought of as co-operable sealing loops extending around the aperture and in a corresponding shape and position on the closure, so that the loops come together and align when the closure is closed. Commonly, one sealing loop is a resiliently flexible seal and the other sealing loop is an inflexible sealing surface against which the resiliently flexible seal seats when the door, lid or other closure is closed. However, it is possible for both sealing loops or indeed neither of them to be resiliently flexible seals. It is also possible for both sealing loops to have associated magnetic means or for just one of the sealing loops to have a magnetic means and for the other to include material capable of attraction to a magnet, such as a steel strip extending around the loop.

It is well known that existing magnetic seals are designed to be pushed together and pulled apart, which characteristic is not appropriate for sealing to a lid around the upper periphery of a drawer. It will be apparent that in the case of a drawer, the opening and closing movement of the drawer will involve relative sliding or wiping movement between at least part of the sealing loops. This is because the lid and the upper periphery of the drawer remain in their original planes, albeit subject to relative translation within those planes, as opposed to experiencing angular movement out of their planes which occurs when a traditional lid or door is hinged open. Typical resilient magnetic seals would be expected to deform and wear

unacceptably if used in such circumstances, and to present excessive frictional resistance to movement of the drawer.

The Applicant's initial thoughts were that resilient magnetic seals would be inappropriate for use with drawer-type appliances of the general type disclosed in WO 01/020237, WO 02/073104, WO 02/073105 and WO 02/073107, and in the Earle and Ewen prior art mentioned above. Indeed, the Applicant's objective was to avoid or minimise relative sliding or wiping movement between seal parts whether magnetic or otherwise. Thus, WO 01/020237 and WO 02/073104 propose alternative seal arrangements involving a minor (typically vertical) component of movement of a drawer to separate the drawer from a fixed lid, hence pulling the sealing loops apart, and a major (typically horizontal) component of movement of the drawer to open the drawer fully for access to its contents. When the drawer is being closed, the major component of movement is followed by the minor component to press the sealing loops back together. This two-component movement avoids or minimises relative sliding or wiping movement between parts of the sealing loops.

Whilst the idea of two-component movement of a drawer has proved to be highly effective, the Applicant has continued to explore alternatives. This effort has been particularly focused upon the appliances disclosed in the Applicant's earlier patent applications WO 01/020237, WO 02/073104, WO 02/073105 and WO 02/073107, in which much of the exterior of the drawers and hence the outside of the drawer/lid interface may be exposed to air at or above ambient temperature. As a result, the Applicant has found that sliding magnetic seals can work successfully in a drawer-type environment and especially in the environments disclosed in the Applicant's abovementioned earlier patent applications.

Thus, in a broad sense, the invention contemplates a storage compartment comprising a container defining an access aperture closable by a closure that can be sealed to the container around the aperture and that can be opened by relative movement between the container and the closure in a lateral direction with respect to the aperture, the container having a first sealing loop around the aperture and the closure having a second sealing loop co-operable by alignment with the first sealing loop to maintain a seal when the closure closes the aperture, wherein the sealing loops are moved into and out of mutual alignment by said relative movement between the container and the closure and wherein at least one

of the sealing loops includes magnetic means for attracting the other of the sealing loops to maintain a seal when the sealing loops are mutually aligned.

The reference to relative movement in a lateral direction with respect to the aperture is intended to encompass sideways relative movement with the effect of translation of the closure across the aperture from one side of the aperture to another.

In the embodiment to be described, the relative movement between the container and the closure causes sliding contact between the sealing loops. To this end, the sealing loops are preferably substantially planar although a minor portion of a sealing loop may be out of the plane of the remainder of the loop, such as being chamfered for clearance. The sealing loops can move in substantially parallel planes and indeed may be substantially coplanar.

In preferred embodiments, the sealing loops comprise sections transverse to the direction of movement and sections aligned with the direction of movement. Those sections may be substantially straight, as is the case where the sealing loops are generally rectangular and define front and rear sections and two side sections connected successively by corners.

The sealing loops are preferably continuous and both sealing loops may include magnetic means, or one of the sealing loops may include magnetic means and the other of the sealing loops may include material that can be attracted to the magnetic means.

It is preferred that at least one of the sealing loops comprises a resiliently flexible seal. In that case, the seal is suitably an elongate member defining generally parallel ridges separated by a web wherein the ridges maintain clearance between the web and a cooperating sealing surface in use. More preferably, a magnetic or magnetically attractive strip extends along the web to press the ridges into sealing contact with the cooperating sealing surface in use.

Where a resiliently flexible seal includes means for magnetic attraction to the other sealing loop, the seal may be arranged to bias those means away from the other sealing loop. The bias may then be overcome in use by increasing magnetic attraction to effect a seal: for example, alignment of the sealing loops may increase magnetic attraction to overcome the bias and effect a seal in use.

Anti-magnetic flux means may be associated with the magnetic means of a sealing loop.

The invention also encompasses a resiliently flexible elongate seal defining generally parallel ridges separated by a web, wherein a magnetic or magnetically attractive strip extends along the web to press the ridges into sealing contact with the cooperating sealing surface in use, whereupon the ridges maintain clearance between the web and the sealing surface. This arrangement minimises friction during sliding movement but maintains a good seal.

In order that the invention may be more readily understood, reference will now be made by way of example to the accompanying drawings in which:

Figures 1(a), 1(b), 1(c) and 1(d) are perspective views from underneath showing a fixed lid and a movable drawer in four different positions relative to the lid;

Figure 2 is a sectional perspective view through opposed seal parts of the lid and drawer shown in Figures 1(a), 1(b), 1(c) and 1(d); and

Figure 3 is an enlarged sectional end view of the seal parts shown in Figure 2.

Referring firstly to Figures 1(a), 1(b), 1(c) and 1(d) of the drawings, a drawer storage appliance such as a refrigerator comprises a closure being a fixed generally horizontal lid 1 and a container being an open-topped drawer 2 that is movable horizontally with respect to the lid. In practice there will usually be more than one such combination of lid and drawer to make a multi-compartment appliance. The drawer 2 is movable over a range of movement extending from being clear of the lid 1 in a fully open position, as shown in Figure 1(a), in which position the interior of the drawer 2 can be freely accessed for the purpose of loading and unloading, to being closed by the lid 1 in a fully closed position, as shown in Figure 1(d).

A skirt 3 depends from the lid 1 to support a first sealing loop 4 being a continuous peripheral downwardly-facing lid seal. The skirt 3 and the lid seal 4 are shaped to correspond to and cooperate with a second sealing loop 5 being a continuous upwardly-

facing sealing surface around the upper peripheral rim defined by generally vertical walls of the drawer 2. The lid seal 4 is resiliently flexible and the sealing surface 5 is relatively stiff such that deflection upon sealing contact between the sealing loops is confined substantially to the lid seal 4.

It is of course possible to reverse the arrangement by having a lid slide relative to a fixed drawer and for an analogous seal arrangement to be used in that event.

It will be apparent that both the lid seal 4 and the sealing surface 5 are continuous loops although those loops could have minor interruptions or discontinuities without necessarily departing from the invention. Moreover, the lid seal 4 and the sealing surface 5 are generally planar, apart from minor chamfering as explained below, and their planes are substantially parallel, indeed practically coplanar, and substantially horizontal. As the drawer 2 moves horizontally, the sealing surface 5 remains in its plane as the drawer 2 moves in use. It follows that the sealing loops move past each other as the drawer 2 is being opened and closed in use, with sliding contact.

In the preferred embodiment shown, the sealing loops defining both the lid seal 4 and the sealing surface 5 are generally rectangular, each defining two parallel straight sections transverse to (indeed orthogonal to) the direction of drawer movement and two parallel straight sections substantially aligned with (indeed parallel to) the direction of drawer movement. Successive sections of the sealing loops are joined by curved corners. Having regard to the direction of drawer movement and the orientation of the drawer 2, the two parallel sections transverse to the direction of drawer movement are referred to herein as a front section and a rear section and the two parallel sections substantially aligned with the direction of drawer movement are referred to herein as respective side sections. Consequently the lid seal 4 and the sealing surface 5 each have a front section, a rear section and two side sections, these sections of the lid seal mirroring their counterpart sections of the sealing surface.

When the drawer 2 is in the fully open position shown in Figure 1(a), there is no alignment between any sections of the lid seal 4 and the sealing surface 5 and hence no significant magnetic attraction between those sealing loops. Upon being partially closed as shown in Figure 1(b), the rear section of the sealing surface 5 of the drawer aligns with the front

section of the lid seal 4. There is magnetic attraction between the parts of the sealing loops that are aligned at these locations but the upper rear edge of the drawer 2 is chamfered downwardly (not shown) to maintain clearance underneath the lid seal 4 and hence to avoid snagging the lid seal 4 as the rear of the drawer passes the front section of the lid seal 4.

Further closing movement brings the drawer 2 to the intermediate position shown in Figure 1(c) where there is alignment between rearward portions of the side sections of the sealing surface 5, and corresponding forward portions of the side sections of the lid seal 4. However, there is no alignment involving the front and rear sections of the sealing surface 5 or of the lid seal 4. Consequently, there is magnetic attraction involving increasing portions of the side sections as the drawer 2 is closed, but the front and rear sections of the sealing surface 5 and of the lid seal 4 contribute no magnetic attraction until the drawer 2 is nearly fully closed as shown in Figure 1(d) and those sections come into mutual alignment as the sealing loops align fully with each other.

Whilst side sections of the lid seal 4 are in sliding contact with side sections of the sealing surface 5 at the aligned locations, the area of contact is small and presents little hindrance to continued closing movement of the drawer 2. It is to be noted in this respect that magnetic seals present substantially less resistance to sliding movement parallel to or within the plane of the seal interface surfaces than they do to being pulled apart transversely or orthogonally to that plane. Tests indicate that the resistance to sliding is typically about one-third of the resistance to being pulled apart. It is also to be noted that the parts of the sealing loops that experience most of the sliding contact, namely the side sections, are best oriented to retain their structural stability under frictional forces which align with the direction of drawer movement and hence with the direction in which the side sections extend. This is particularly useful in maintaining the integrity of the flexible lid seal 4 in use.

Tests of the rectangular sealing loop arrangement shown in Figures 1(a) to 1(d) suggest that upon drawer opening, the corners linking successive sections of the lid seal 4 are first to release. This helps, in effect, to peel the neighbouring sections of the lid seal 4 progressively away from the sealing surface 5 of the drawer. This peeling action further

reduces distress to the lid seal 4 and the effort of drawer opening but without prejudicing the sealing integrity of the seal when the drawer 2 is closed.

In summary, then, the aggregate magnetic attraction between the sealing loops peaks when the sealing loops are fully aligned, as occurs when a drawer is fully closed with respect to a fixed lid or vice versa. When the sealing loops are not fully aligned, which is the case throughout substantially all of the range of movement of the drawer or lid other than when fully closed, the aggregate magnetic attraction between them decreases markedly.

Turning now to Figures 2 and 3 of the drawings, these show the lid seal 4, the opposed sealing surface 5 and the surrounding lid and drawer structures in detail.

The skirt 3 depending from the lid 1 is a U-section channel whose flat bottom surface carries a central elongate groove undercut to form an enlarged elongate recess of triangular section symmetrical about the central longitudinal plane of the groove. The lid 1 and its skirt 3 are substantially solid but of insulating material.

The opposed sealing surface 5 of the drawer 2 is a flat top surface of a generally vertical wall 6 of the drawer 2, which wall is hollow and filled with insulation 7. An oblong-section magnetic strip 8 extends centrally along the top 9 of the wall, in the top of an inverted T-section groove on the under-surface of the top wall 9 within the hollow cross section, such that the strip 8 is concealed under the top surface of the wall 9. An elongate anti-magnetic flux plate 10 of carbon steel extends along the bottom of the inverted T-section groove, beneath the magnetic strip 8, where it retains the strip 8 in the top of the T-section and is supported by the insulation 7 filling the hollow cross-section of the wall 6. The anti-magnetic flux plate 10 is provided with surface protection to resist corrosion.

It will be seen from Figures 2 and 3 that flanges 11 extend outwardly to both sides of the wall of the drawer, but these flanges 11 are for support purposes not related to the present invention.

The lid seal 4 shown in Figures 2 and 3 is a flexible resilient strip, suitably extruded or moulded, that is symmetrical about its central longitudinal plane. Looking from top down as illustrated, the seal comprises an anchor portion 12 of arrowhead cross-section shaped to

be snap-fitted into the undercut groove in the bottom face of the skirt 3. Beneath that, tapering flanges 13 extend laterally from the base of the arrowhead anchor portion 12 to bear resiliently against the bottom face of the skirt 3 and so to hold the seal 4 stably against the skirt 3. Beneath the flanges 13, the strip is of hollow cross section and comprises a narrow waist portion 14 extending inwardly below the flanges above a flared base portion. The base portion has rounded lobes 15 that curve outwardly and downwardly from the waist portion 14 and then inwardly and slightly upwardly, towards each other, to support a central generally flat web 16. Consequently, the web 16 is slightly above and between a pair of rounded sealing ridges defined by the lobes 15, which ridges together define the lowest level of the lid seal 4 and hence the sealing interface with the opposed sealing surface of the drawer 2.

The flat web 16 of the lid seal contains a channel running the length of the seal that holds a further magnetic strip 17 within the hollow cross-section of the seal 4. In use, this strip 17 is attracted to the magnetic strip 8 associated with the sealing surface of the drawer 2, to pull the flexible lid seal 4 into sealing engagement with the sealing surface 5. The purpose of the anti-magnetic flux plate 10 is to prevent or reduce like-pole repulsion between the magnetic strips, hence reducing seal distortion and assisting seal alignment in use. Of course, it would also be possible for only one of the strips to be magnetic and for the other to be of a material, particularly ferrous material, that attracts or is attracted to the sole magnetic strip.

It will be apparent from the enlarged cross-sectional view of Figure 3 that as the lobes 15 to either side of the central web 16 of the lid seal can hold that web clear of the sealing surface 5 of the lid, contact with the sealing surface 5 is restricted to two parallel lines of contact, one under each lobe 15 of the lid seal 4. Consequently, there is minimal frictional resistance to relative sliding movement between the lid seal 4 and the drawer 2. However, the efficacy of sealing is maintained because the magnetic attraction is exerted over a relatively small surface contact area, hence increasing sealing pressure, and because there are, in effect, two seal areas rather than one. Consequently, if one seal is compromised by, for example, dirt deposits preventing a good seal, there is a good chance that the other seal will remain unaffected by the same problem and hence will still be effective.

The seal arrangement enabled by the invention has other advantages, in some cases unexpected. For example in conventional refrigeration, especially freezers, it is common practice to provide trace heating to the magnetic seal surface to prevent condensation and icing. The Applicant has tested its magnetic seal over the full range of storage and ambient conditions likely to be encountered in service. This testing has been in the context of the appliances disclosed in the Applicant's earlier patent applications WO 01/020237, WO 02/073104, WO 02/073105 and WO 02/073107, in which much of the exterior of the drawers and hence the outside of the drawer/lid interface may be exposed to air at or above ambient temperature. No problems have been experienced with icing, which would normally manifest itself as sticking seals; instead, the Applicant has found generally acceptable formation of condensation between the surfaces of the seal which remains largely in liquid form as moisture rather than ice. Significantly, it has been found that this moisture assists the purposes of the invention by acting as a lubricant to relative sliding movement, and in that the wiping action between moisture-bearing sliding surfaces helps to keep the seal surfaces clean. The invention therefore provides a self-lubricating and self-cleaning seal in which trace heating is not necessary.

Further, it has been explained above in relation to Figures 1(a) to 1(d) that the aggregate magnetic attraction between the lid seal 4 and the sealing surface 5 depends upon the degree of alignment of those sealing loops. In approximate terms, the aggregate force of attraction halves soon after the drawer has been opened because the front and rear sections of the respective sealing loops come out of mutual alignment. The Applicant has realised, somewhat counter-intuitively, that this characteristic can be enabled and exploited by designing a magnetic seal to have resilience that biases the magnetic element of that seal *away* from the opposing sealing surface. The seal may be further designed such that this resilience overcomes the weakened aggregate magnetic attraction when the sealing loops as a whole are misaligned but is itself overcome by the stronger aggregate magnetic attraction when the sealing loops as a whole are aligned. In this way, the area of contact between the seal parts can be reduced or eliminated when the drawer is not fully closed, especially where freedom of movement is required during opening and closing, and conversely can be maximised when the drawer is fully closed and hence sealing is required. In other words, with careful design, a seal can be arranged (i) to extend into full sealing contact with an opposed sealing surface when the drawer is fully closed and (ii) to retract into lesser sliding contact, or possibly even entirely out of contact, with the opposed

sealing surface when the drawer is at other positions, for example when being opened or closed.

CLAIMS

1. A storage compartment comprising a container defining an access aperture closable by a closure that can be sealed to the container around the aperture and that can be opened by relative movement between the container and the closure in a lateral direction with respect to the aperture, the container having a first sealing loop around the aperture and the closure having a second sealing loop co-operable by alignment with the first sealing loop to maintain a seal when the closure closes the aperture, wherein the sealing loops are moved into and out of mutual alignment by said relative movement between the container and the closure and wherein at least one of the sealing loops includes magnetic means for attracting the other of the sealing loops to maintain a seal when the sealing loops are mutually aligned.

2. The compartment of Claim 1, wherein the relative movement between the container and the closure causes sliding contact between the sealing loops.

3. The compartment of Claim 1 or Claim 2, wherein the sealing loops are substantially planar.

4. The compartment of Claim 3, wherein a minor portion of a sealing loop is out of the plane of the remainder of the loop.

5. The compartment of Claim 3 or Claim 4, wherein the sealing loops move in substantially parallel planes.

6. The compartment of any of Claims 3 to 5, wherein the sealing loops are substantially coplanar.

7. The compartment of any preceding Claim, wherein the sealing loops comprise sections transverse to the direction of movement and sections aligned with the direction of movement.

8. The compartment of Claim 7, wherein the sections are substantially straight.

9. The compartment of Claim 8, wherein the sealing loops are generally rectangular and define front and rear sections and two side sections connected successively by corners.

10. The compartment of any preceding Claim, wherein the sealing loops are continuous.

11. The compartment of any preceding Claim, wherein both sealing loops include magnetic means.

12. The compartment of any of Claims 1 to 10, wherein one of the sealing loops includes magnetic means and the other of the sealing loops includes material that can be attracted to the magnetic means.

13. The compartment of any preceding Claim, wherein at least one of the sealing loops comprises a resiliently flexible seal.

14. The compartment of Claim 13, wherein the seal is an elongate member defining generally parallel ridges separated by a web wherein the ridges maintain clearance between the web and a cooperating sealing surface in use.

15. The compartment of Claim 14, wherein a magnetic or magnetically attractive strip extends along the web to press the ridges into sealing contact with the cooperating sealing surface in use.

16. The compartment of any of Claims 13 to 15, wherein the resiliently flexible seal includes means for magnetic attraction to the other sealing loop and biases said means away from the other sealing loop, said bias being overcome in use by increasing magnetic attraction to effect a seal.

17. The compartment of Claim 16, wherein alignment of the sealing loops increases magnetic attraction to overcome the bias and effect a seal in use.

18. The compartment of any preceding Claim and including anti-magnetic flux means associated with the magnetic means of a sealing loop.

19. A resiliently flexible elongate seal defining generally parallel ridges separated by a web, wherein a magnetic or magnetically attractive strip extends along the web to press the ridges into sealing contact with a cooperating sealing surface in use, whereupon the ridges maintain clearance between the web and the sealing surface.

20. A storage compartment, substantially as hereinbefore described with reference to or as illustrated in any of the accompanying drawings.

21. A seal, substantially as hereinbefore described with reference to or as illustrated in Figure 2 or Figure 3 of the accompanying drawings.

ABSTRACT

A storage compartment comprises a container defining an access aperture closable by a closure that can be sealed to the container around the aperture and that can be opened by relative movement between the container and the closure in a lateral direction with respect to the aperture, the container having a first sealing loop around the aperture and the closure having a second sealing loop co-operable by alignment with the first sealing loop to maintain a seal when the closure closes the aperture. The sealing loops are moved into and out of mutual alignment by said relative movement between the container and the closure and at least one of the sealing loops includes magnetic means for attracting the other of the sealing loops to maintain a seal when the sealing loops are mutually aligned.

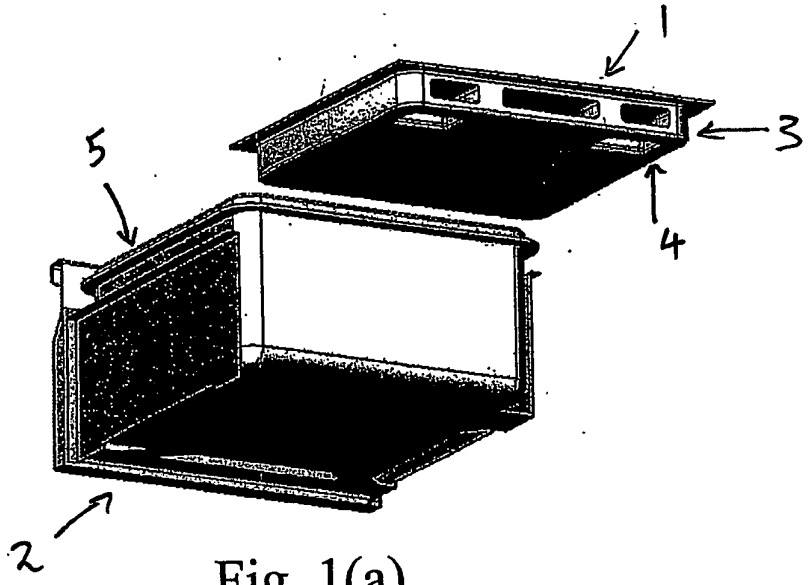

Fig. 1(a)

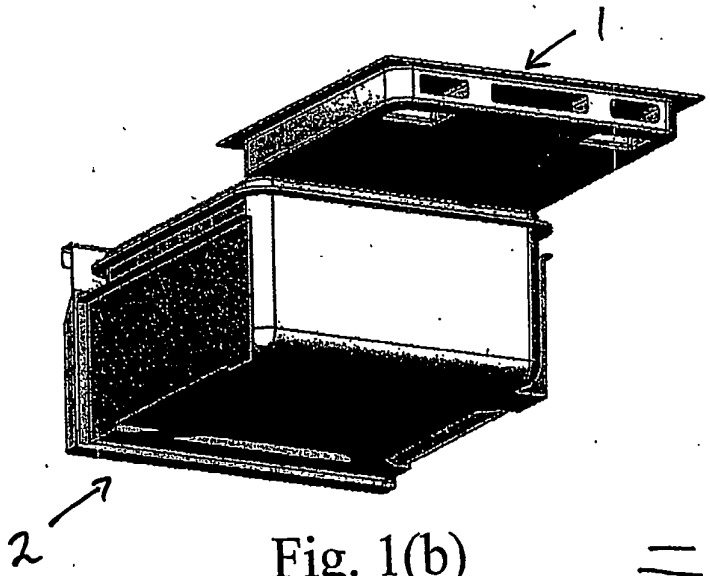

Fig. 1(b)

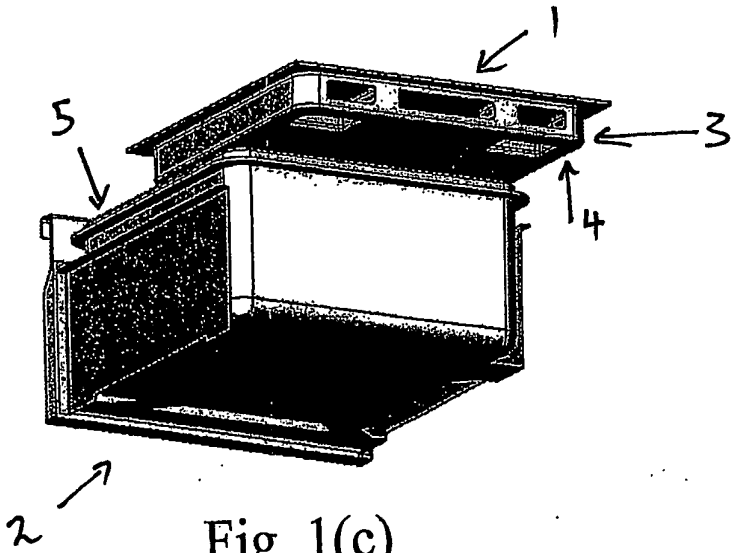

Fig. 1(c)

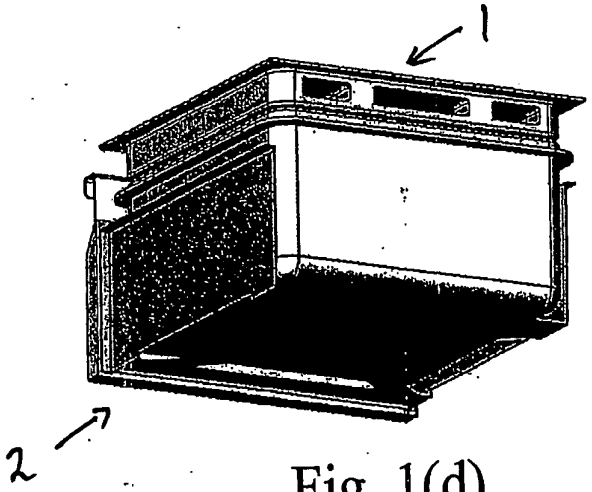

Fig. 1(d)

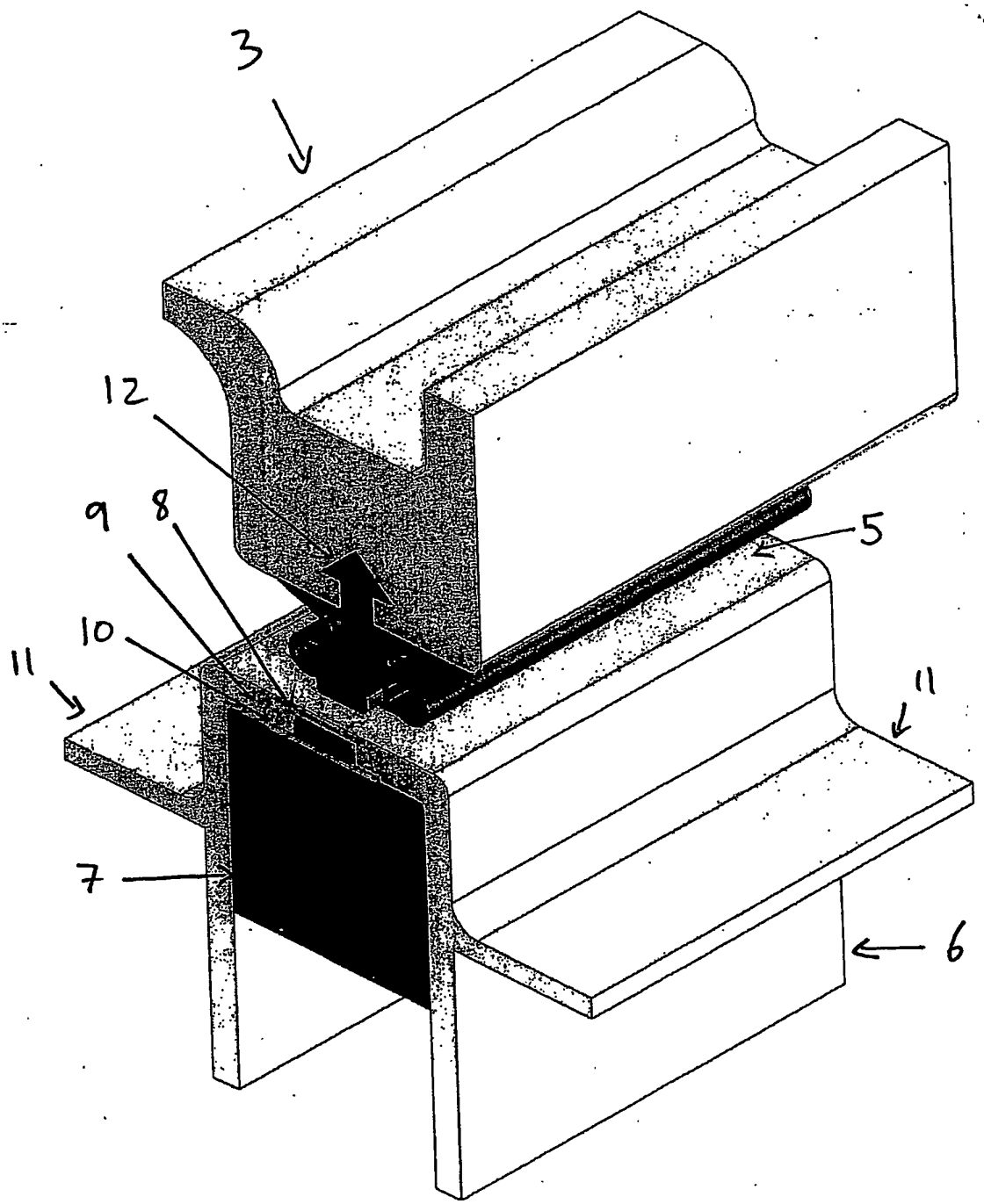

Fig 2

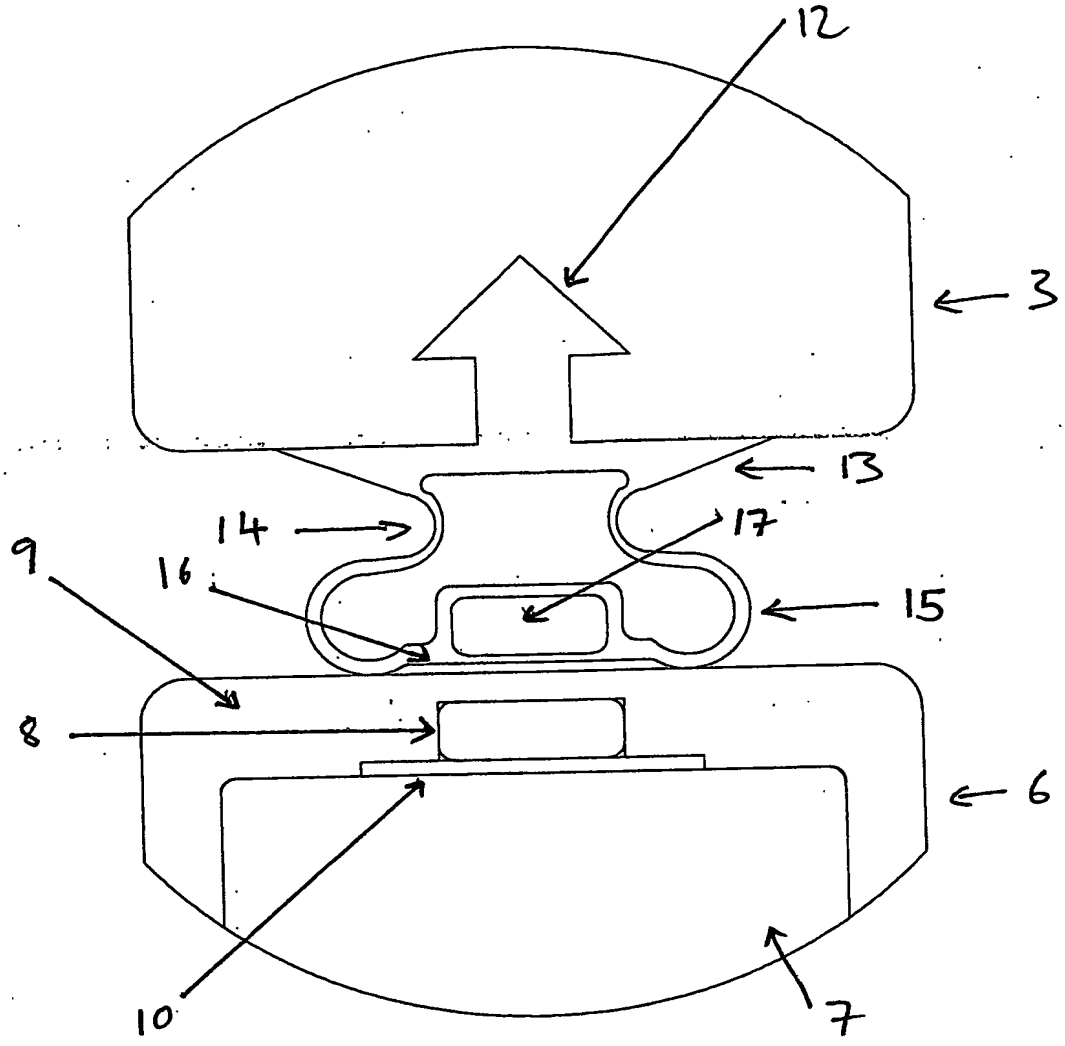

Fig. 3